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## CSR2 – SOIL PRODUCTIVITY RATING FOR CROPLAND IN IOWA, USA

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*The Iowa Corn Suitability Rating (CSR2) is a soil productivity rating system used primarily for taxation purposes on cropland in Iowa and is derived from its original version “CSR.” CSR2 was created using seven transparent parameters that allow for efficient calculation.*

**Soil productivity; Taxation; Soil taxonomy; Soil physical features; Equation.**

CSR2 is a derivation of Iowa’s original “corn suitability rating” developed by Fenton and others [1,2]. The original CSR was a significant, quantitative advance on earlier productivity ratings [3], developed in result of rapidly rising crop worth, farmland value, and land rental values in Iowa as well as to meet the State of Iowa’s rural land taxation laws. Fenton and others [1] used statistics to link crop yields to the then 290 soil series in Iowa. Their yield data came from sites in 15 counties distributed across Iowa. The pedological information came from soil surveys and their laboratory data [4]. Fenton and his coauthors also heavily relied on their extensive expert knowledge of the soils and farming of Iowa. CSR remains very, very highly regarded even after 40 years. Its limitation is poor compatibility with Soil Taxonomy, the USA’s official soil classification system since 1975.

Our objective is a transparent system for calculating CSR2 that results in values nearly identical to the original CSR values. Our hypothesis is the CSR2 of a soil map unit (SMU) is a function of: (a) Soil Taxonomy subgroup, (b) Soil Taxonomy family particle size, (c) field conditions indicated in the SMU, (d) soil water holding capacity, (e) soil thickness, (f) local climate, and, (g) expert judgment.

**Methods.** We statistically deconstructed CSR in order to obtain quantitative values for each of our seven parameters.

**Results & Discussion.** Determining CSR2 for a SMU that contains only one soil series.

$$\text{Equation 1: } \mathbf{CSR2 = S-M-F-W-D-C \pm EJ}$$

Where:

**S** is the taxonomic subgroup class of the series of the soil map unit (SMU) series,

**M** is the family particle size class,

**F** refers to the field conditions of a particular SMU,

**W** relates to available water holding capacity of the series,

**D** is a soil depth factor and ties to tolerable rates of soil erosion,

**C** refers to the climate and microclimate of the SMU and the county,

**EJ** is an expert judgment correction factor.

Equation 1 is for a SMU that is entirely composed of a single soil series. It is recognized that real SMU’s routinely include more than one soil series in which

case a weighted area average CSR will be calculated. Values for the factors will not be listed herein.

The first component of CSR2 is to insure soil series having similar properties – regardless of where they are located across Iowa – are assigned comparable productivity indices. Our statistical analysis indicates the best way to do this was to group Iowa's 500-plus soil series according to their Soil Taxonomy subgroup. The usefulness of subgroups is not surprising given the sophisticated amount of soil morphology captured at this level of Soil Taxonomy.

We decided to make family particle size class our second component because it is a useful proxy to soil parent material and texture, both which were direct parameters in the original CSR formula. We call this factor "M." We assigned these using our statistical evaluation of current CSR values. The S term and the M term are universally available, easily found and routinely updated online at: <https://soilseries.sc.egov.usda.gov/osdname.asp>

The F-factor refers to all field conditions recognized on a soil map that affect a soil's productivity but are not part of the internal soil morphology. Pertinent conditions include slope, erosion and sediment history, channelization, flooding, and ponding. These values are the statistical mean of their existing weight in the current CSR system. The W-factor adjusts CSR2 according to available water storage. The D-factor integrates CSR2 with soil erosion risk and history. The C-factor refers to the climatic limitations recognized in the current CSR system.

Our final factor is "expert judgment" (EJ). It is limited to 15-points and will rarely be used. We include it because soil productivity is a complex property that extends beyond our seven parameters. It is assigned via mutual agreement of between several agencies. It is limited to 15 points to minimize risk of bias while at the being large enough to allow meaningful yield limitations can be adjusted.

### **Conclusion**

This paper provides a new method to determine crop productivity values for the soils of Iowa. Three interrelated features of CSR2 are (a) its linkage to Soil Taxonomy, (b) its use of national soil survey databases, and (c) the ease to which it can be updated. A drawback is that little field-testing has been conducted to evaluate the accuracy of this approach.

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*Оцінка оптимальних умов вирощування кукурудзи (CSR2) є системою оцінки родючості ґрунтів, яка використовується в першу чергу для визначення податку на землю сільськогосподарських угідь штату Айови й*

була розроблена на основі попередньої «CSR» версії. CSR2 система основана на використанні семи параметрів, які легко обраховуються.

**Родючість ґрунтів, рента, таксономія ґрунтів, фізичні особливості ґрунтів, рівняння.**

Оценка оптимальных условий выращивания кукурузы (CSR2) является системой оценки плодородия почв, которая используется в первую очередь для определения налога на землю сельскохозяйственных угодий штата Айовы и была разработана на основе предыдущей «CSR» версии. CSR2 система основана на использовании семи параметров, которые легко рассчитываются.

**Плодородие почвы; рента, таксономия почв, физические особенности почв, уравнение.**